

3.10 NOISE

A. Background Information

This section gives background information on the key topics related to noise at Ames Research Center, including a discussion of the basic properties of sound, the health effects of noise, a general overview of noise and human response, noise and weather effects, and the effects of airborne noise-induced vibration.

The key technical terms used in this chapter are defined in Table 3.10-1.

1. Noise Exposure

Noise exposure measurements are a way of measuring the average dose of noise over a period of time. Noise exposure measurements correlate more closely with human response to noise annoyance than do absolute or instantaneous noise level measurements because they consider both the noise level and the duration of noise events. For this reason, nearly all noise criteria used for land use compatibility are based on noise exposure rather than noise level.

Noise exposure contours show lines of equal noise exposure. Contour values become smaller with distance from the noise source to reflect the reduction of the noise as it travels across the earth's surface. Noise exposure contours will typically be numerically smaller than noise level contours for an individual noise event, since measurements of noise exposure take account of both periods of relative quiet and noise events. Examples of noise exposure descriptors are CNEL and DNL (quantity symbol L_{dn}). Noise exposure impacts are addressed in Section 4.10.

All noise levels and noise exposure levels throughout this document are A-weighted in accordance with appropriate standards and criteria. All such values are in units of decibels, whose unit symbol is “dB” in conformance with American National Standard ANSI/ASME Y10.11-1984. The unit symbol “dBA” is not the standard symbol used under ANSI Y10. 11. All numerical noise values in this document symbolized “dB” are numerically identical to those using “dBA,” often found in other references.

TABLE 3.10-1 DEFINITIONS OF ACOUSTICAL TERMS

Term	Definitions
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01} , L_{10} , L_{50} , L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 pm to 10:00 pm and after addition of 10 decibels to sound levels measured in the night between 10:00 pm and 7:00 am.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 pm and 7:00 am.
L_{max} , L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

Source: Illingworth & Rodkin.

Typical environmental noise levels are shown in Table 3.10-2.

2. Sound Propagation Attenuation

Several factors account for sound attenuation, or sound reduction, as it travels from a source, as described below:

a. Hemispherical Spreading

Sound is always attenuated by hemispherical spreading, which generally is the reduction of the sound pressure level, or noise level, as the sound travels over a surface, usually the earth. This is the same phenomenon as the intensity of light diminishing with distance from the light source. Hemispherical spreading occurs at the rate of 6 dB per doubling of the distance from the source.

All frequencies of a sound attenuate uniformly over a surface by hemispherical spreading. The results of hemispherical spreading are affected by the directivity characteristics of the sound source.

Complex sound sources emit more sound energy in one direction than another. These effects are much more pronounced close to the source than they are further away. As the distance from any noise source becomes larger, sound energy emanating from the source becomes more equal in any given direction. Therefore, noise contours drawn to illustrate the sound energy become more circular as they get further away from the sound source.

b. Air Absorption

Air absorption, unlike hemispherical spreading, attenuates sound at a particular frequency uniformly with distance. Air absorption dramatically affects high frequency sound while providing little or no attenuation of low frequencies. An example of this phenomena is when aircraft jet engines appear to shrill when up close, but produce only a low roar at distant locations. Though sound is attenuated through air absorption at all times, the degree of attenuation varies with the weather.

TABLE 3.10-2 **TYPICAL SOUND LEVELS IN THE ENVIRONMENT AND INDUSTRY**

At a Given Distance From Noise Source	A-Weighted Sound Level in Decibels	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100')	130		
Jet Takeoff (200')	120		Pain Threshold
	110	Rock Music Concert	
Diesel Pile Driver (100')	100		Very Loud
Freight Cars (50')	90	Boiler Room Printing Press Plant	
Pneumatic Drill (50')	80		
Freeway (100')		In Kitchen With Garbage Disposal Running	Moderately Loud
Vacuum Cleaner (10')	70		
	60		
Light Traffic (100')	50	Data Processing Center	
Large Transformer (200')			
	40	Department Store	Quiet
Soft Whisper (5')	30	Private Business Office	
	20		
		Quiet Bedroom	
	10	Recording Studio	Threshold of Hearing
	0		

Source: Illingworth & Rodkin.

c. Sound Refraction

Sound refraction is a bending of sound, typically around some type of barrier, which can either increase or decrease the sound attenuation at a given location. A common example of a barrier which causes sound refraction is a freeway sound wall. Sound walls have the effect of substantially reducing noise to areas immediately protected by the noise barrier, while possibly reflecting the noise to new locations in the immediate vicinity of the barrier. In general, sound walls or other types of barriers have negligible attenuation to more distant locations beyond the noise source or barrier. Sound refraction can also be caused by both temperature gradients and by wind, as described below.

i. Sound Refraction by Temperature Gradients

When temperatures are constant with altitude (isothermal conditions), no atmospheric sound refraction occurs. However, when temperatures vary with altitude (temperature gradients) sound refraction can occur.

A negative temperature gradient exists when cooler air is found above warmer air. This typical condition refracts sound waves up and away from the surface of the earth and can attenuate sound by as much as 25 dB at distances less than 0.8 kilometers (half a mile).

A positive temperature gradient occurs when warmer air is found above cooler air. This condition, known as thermal inversion or an inversion layer, refracts sound waves toward the surface of the earth. While thermal inversion has little or no effect at short distances, it tends to reduce or eliminate the attenuation effects of ground absorption and barriers over long distances. Thus, sound tends to carry further under thermal inversion conditions. As a result, this condition can cause substantial increases in noise transmission.

Thermal inversion is known to occur fairly often in the Mountain View area. This effect has contributed to the ongoing dispute between the cities of Palo Alto and Mountain View over Shoreline Amphitheater concert noise.

However, temperature gradients are unpredictable and they do not lend themselves to evaluating predictable long-term effects.^{1,2}

ii. Sound Refraction by Wind

Steady, low velocity wind has a negligible effect on sound propagation. However, high velocity wind or changes in wind conditions with altitude (wind speed gradients) can produce refractive effects similar to those for temperature gradients. Sound propagation in the direction an item would be carried by the wind (downwind) results in sound waves refracting toward the earth. Like a temperature inversion, this has little or no effect at short distances. It does, however, reduce the refractive effects of surface barriers over long distances. Sound propagation upwind refracts the sound up and away from the earth. As with a negative temperature gradient, this may result in additional attenuation of up to 25 dB at distances less than three kilometers.

Both upwind and downwind effects are only measurable for steady long-term average wind velocities in excess of 10 knots.^{3,4} Climatic data for the project area indicates that average wind velocity typically exceeds 10 knots for a few

¹ L.N. Miller. *Noise Control for Buildings and Manufacturing Plants*. Bolt, Beranek, and Newman. Cambridge, MA. 1981.

² R.T. Harrison. R.N. Clark, and G.H. Stankey. *Predicting impacts of Noise on Recreationists*. Project Report, Forest Service. U.S. Department of Agriculture. April 1980.

³ D. N. Keast. *Procedure for Predicting Noise Environments Around Industrial Sites*. Bolt, Beranek, and Newman Report No. 2997. Prepared for the Long Island Lighting Company. September 1974.

⁴ L.L. Beranek. *Noise and Vibration Control*. McGraw-Hill. New York, New York. 1971.

hours in the afternoon of the summer months. These north-by-northeast winds may result in some upwind or downwind refraction during these times.^{5,6}

Additionally, gusty winds can scatter sound over large distances; however, this effect is only transitory and cannot be reliably predicted.⁷ Wind can also generate its own noise, such as the rustling of trees, which raises the background noise and may diminish the intrusive effects of a distant noise source.

3. Airborne Noise-Induced Vibration

One aspect of community response to noise involves high levels of low-frequency airborne sound that can induce building vibration. This phenomenon sometimes occurs in conjunction with ground vibration, as in the case of nearby train passbys, or can occur without perceptible ground vibration, as is typical with wind tunnel or aircraft noise. In this report, only airborne noise-induced vibration will be discussed since ground vibration is not expected to occur.⁸

House structures have many components that can readily be excited by noise and respond as complex vibrating systems.⁹ Airborne vibration, or “rattling”,

⁵ NASA Ames Research Center. *Naval Air Station Moffett Field Existing Conditions Report. Phase 2*. NASA Ames Research Center Facilities Planning Office. May 22. 1992.

⁶ Western Regional Climate Center. *Hourly Wind Data*. Reno, Nevada. Information extracted from copies of the historical National Climate Data Center (NCDC) Surface Airways Hourly Tapes. March 3. 1995.

⁷ L.N. Miller. *Noise Control for Buildings and Manufacturing Plants*. Bolt, Beranek, and Newman. Cambridge, MA. 1981.

⁸ Nelson, P.N. *Transportation Noise Reference Book*. Butterworths. London 1987.

⁹ Hubbard, H.H. *Noise-Induced House Vibrations and Human Perception*, *Noise Control Engineering Journal*, 19, 49-55. 1982.

is usually heard when noise emanates from the following items, which are listed, in decreasing likelihood of vibration:

- Windows
- Lightweight, lay-in ceiling tiles
- Walls
- Floors
- Dishes, ornaments and lamps due to the vibration of either the walls or the floors

Additionally, noise-induced vibration can sometimes be felt through windows, walls or floors by the touch of finger tips, and in extreme cases, damage to the item, such as plaster and tile, could occur from vibration. These phenomena are generally observable with very high sound pressure levels at frequencies below 300 Hz.

4. Effects of Noise

This section discusses some of the health effects and other responses that can occur as a result of noise.

a. Hearing Loss

Hearing loss is the primary health risk associated with high noise levels. People who are exposed to an excessive amount of noise develop permanent hearing loss. In most persons, the beginning of noise-induced hearing loss is hard to define, but it follows repeated exposure to industrial or recreational noise, such as loud music. Damage to the inner ear generally does not create pain or any other obvious sensory response or alarm. Loss of hearing can result from exposure to impulse or impact noise as well as from exposure to steady-state (continuous) noise. The hearing loss caused by excessive exposure to noise is a permanent impairment, and no surgical procedure or medical device can

restore the hearing to normal. Thus, prevention is the only way to avoid noise-induced hearing loss.¹⁰

The ear is injured by noise in two very different ways, depending upon the level of exposure. First, instantaneous peak sound pressure levels in excess of 140 dB can stretch the delicate inner ear tissues beyond their elastic limits, and rip or tear them apart. This type of damage is called acoustic trauma. Second, exposures to noise between 85 and 140 dB damage the ear metabolically, rather than mechanically. In this case, the potential for damage and hearing loss depends on the levels and the duration of exposure. This type of injury is called noise-induced hearing loss (NIHL) and, in contrast to acoustic trauma, is cumulative and grows over years of exposure.

Hearing damage has been studied extensively in the United States, resulting in the noise exposure standards of the Department of Labor's Occupational Safety and Health Administration (OSHA). Additionally, the NASA Health Standard on Hearing Conservation (NHS/IH-1845.4) establishes minimum requirements for hearing protection. Both of these regulatory mechanisms are discussed in more detail in Section B. I of this chapter.

b. Non-Auditory Health Effects

Short-term exposure studies have demonstrated that noise is capable of eliciting a variety of acute physiological and biochemical responses in humans. These responses appear to represent a generalized biologic stress reaction involving sympathetic activation of the autonomic nervous system. These include symptoms such as an increase in blood pressure, other forms of physical stress, and an overall increase in psychological stress.

Physical stress reactions can be observed when people are exposed to noise levels of 85 dB or more. Dilated pupils, elevated blood pressure, and an

¹⁰ American Family Physician. *Adverse Effects of Noise on Hearing*. Volume 47. Pages 1219- Robert S. Bahadori and Barbara A. Bohne. 1992.

increase of stomach acid leading to a nauseous feeling are typical reactions when the noise environment is increased above those levels normally found in a community noise environment. There is disagreement among experts as to whether these reactions pose a threat to health, with long-term exposure.

Psychological stress varies from individual to individual. This type of stress can be caused by sleep disturbance, inability to carry on a conversation, or other annoying factors of noise. The community standards described in Section B.2 of this chapter have been designed for sleep protection. When a noise environment exceeds these standards sleep disturbance, and thus psychological stress, may occur. Noise above 65 dB makes it difficult to have a normal conversation without raising one's voice, and could cause psychological stress in certain individuals.

c. Noise and Human Response

It is widely recognized that human response to noise is subjective and varies considerably among individuals. Unfortunately, there is no completely satisfactory way to measure the subjective effects of noise, or of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individuals' thresholds of annoyance, habituation to noise, and differing individual past experiences with noise. An important factor in assessing a person's subjective reaction to noise is comparing existing noise to proposed noise. Generally, the more a new noise exceeds existing noise, the less acceptable it is to the community. Therefore, a new noise source would be judged more annoying in a quiet area than it would in be in a noisier location. Knowledge of the following relationships is helpful in understanding how changes in noise and noise exposure are perceived:

- Except under special conditions, a change in sound level of 1 dB cannot be perceived.
- Outside of the laboratory, a 3 dB change is considered a just-noticeable difference.

- A change in level of at least 5 dB is required before any noticeable change in community response would be expected.
- A 10 dB change is subjectively heard as an approximate doubling in loudness and often causes an adverse community response.

Noise and land use compatibility guidelines generally correlate with widely accepted annoyance levels of a community. These regulations are discussed in more detail in Section B.2 of this chapter.

B. Regulatory Environment

1. Hearing Conservation Standards¹¹

Given the concerns outlined in Section A, the Department of Labor's Occupational Safety and Health Administration (OSHA) has developed noise exposure standards for U.S. workers. These noise exposure standards allow for noise levels of 90 dB for 8 hours per day and decreasing exposure duration for higher noise levels up to a maximum of 115 dB for 15 minutes or less without hearing protection. These standards apply to virtually all industries within the United States.

The NASA Health Standard on Hearing Conservation (NHS/IH-1845.4) establishes minimum requirements for the NASA Agency-wide Hearing Conservation Program. This standard is applicable to all NASA employees and NASA controlled, government-owned facilities. Permissible exposure limits outlined by the NASA Hearing Conservation Program vary with the sound

¹¹ *Department of Labor Occupational Noise Exposure Standard*. 29 C.F.R. Part 1910, subpart G.

TABLE 3.10-3 **PERMISSIBLE EXPOSURE LIMITS FOR NOISE ACCORDING TO
NASA'S HEARING CONSERVATION PROGRAM**

Duration (Hours)	dBA*
16	80
8	85
4	90
2	95
1	100
0.5	105
0.25	110
0.125 or less	115

Notes:

* dBA is the abbreviation for the A-weighted sound level. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear. All noise levels and noise exposure levels throughout this document are A-weighted in accordance with appropriate standards and criteria. All such values are in units of decibels, whose unit symbol is "dB" in conformance with American National Standard ANSI/ASME Y10. 11- 1984. The unit symbol "dBA" is not the standard symbol used under ANSI Y10.11. All numerical noise values in this document symbolized "dB." are numerically identical to those using "dBA." often found in other references.

pressure level of the noise, as detailed in Table 3.10-3. It is NASA policy to control noise generated by NASA operations and to prevent occupational noise-related hearing loss. In accordance with this policy, maximum permissible exposure limits have been established to provide an environment free from hazardous noise.

The Hearing Conservation Program establishes a noise hazard area as any work area with a noise level of 85 dBA or greater. Thus, NASA's program is 5 dB more stringent than that of OSHA. Earmuffs or earplugs are to be provided to attenuate employee noise exposure to a level below 85 dBA. A combination of both car muffs and plugs are to be required where noise levels equal or exceed 110 dBA.

2. Land Use Hearing Conservation Standards

The nuisance effects of noise have traditionally been addressed in terms of noise annoyance. This annoyance is known to be associated with the level of noise, the duration of the noise, and increased sensitivity to evening and nighttime noise. Since 1972, when Congress enacted the Noise Control Act (NCA),¹² several documents have been published that provide guidance on assessing the nuisance and annoyance effects of noise, and related land use compatibility issues. The following is a summary of the documents most applicable to assessing noise and land use compatibility for Ames Research Center.

- *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (1974)*. The NCA of 1972 required the Environmental Protection Agency (EPA) to publish information on acceptable community noise levels. The result was EPA550/9-47-004, which is commonly referred to as the “Levels Document”. This document establishes the DNL as the preferred community noise descriptor, with DNL values being directly related to the

¹² Noise Control Act (NCA), Public Law 92-574 (42 U.S.C. 4901 et seq).

percentages of the community that would be annoyed by particular noise exposures.

- *Guidelines for Considering Noise in Land Use Planning and Control (1980).* In late 1979, the Federal Interagency Committee on Urban Noise (FICUN) was formed to unify noise policy among various Federal agencies. In 1980 it published *Guidelines for Considering Noise in Land Use Planning and Control*, which confirms DNL as the descriptor to be used for all noise sources. In 1992, a second interagency committee, the Federal Interagency Committee on Noise (FICON), published its *Federal Agency Review of Selected Airport Noise Analysis Issues*, which again confirms DNL as the best cumulative noise exposure measurement.
- *Sound Level Descriptors for Determination of Compatible Land Use (1990).* In 1990, the American National Standard Institute (ANSI) revised its 1980 standards for sound level descriptors for land use compatibility assessment to confirm DNL as the acoustical measure for assessing compatibility between various land uses and the outdoor noise environment.
- *General Plan Guidelines (1990).* Also in 1990, the California Governor's Office of Planning and Research (OPR) published guidelines to aid California municipalities in preparing their General Plans. This document uses the CNEL and DNL noise descriptors interchangeably to relate land use compatibility for community noise environments.

The most commonly used noise exposure measure for environmental noise is DNL or L_{dn} . This is a night penalized average used for most noise and land use compatibility criteria. The day-night average sound level is obtained after the addition of ten decibels (10 dB) to noise levels measured in the night between 10:00 p.m. and 7:00 a.m. In California, an alternative measure is the CNEL, which is similar to DNL except a 5 dB penalty is added during the evening hours of 7:00 to 10:00 p.m. Because DNL and CNEL nearly always render results within 1 dB, they can generally be compared in land use compatibility analyses.

In general, noise criteria apply to land use compatibility for new development. These criteria are specified in terms of exterior noise levels, although the noise sensitive area may be indoors. Various methods exist for the accurate prediction of sound transmission loss and sound level reduction to the indoor environment. For the purposes of this EIS, noise criteria are presented in exterior noise levels.

No State or local noise criteria are binding on the type of noise to be created by the NASA Ames Research Center. NASA attempts, whenever possible, to meet local guidelines and standards and considers them as advisory in nature. Despite the lack of binding regulation, NASA uses the following noise guidelines and regulations in this EIS to provide guidance for determining the relative impact of the proposed project:

- *Federal Criteria.* Three federal criteria provide guidance in determining noise impacts. These are the noise criteria from the Department of Housing and Urban Development (HUD), those from the Federal Aviation Administration (FAA), and guidelines created by the Army.
- *State Criteria.* The State of California Guidelines for preparation of Noise Elements of General Plans and the Caltrans Division of Aeronautics noise exposure criteria provide guidance in determining noise effects.
- *Local Criteria.* Local criteria that provide guidance near NASA Ames include noise criteria from the City of Mountain View, the City of Sunnyvale, and Santa Clara County.

Specific federal, State, and local land use compatibility noise criteria are described below and are summarized in Table 3.10-4. These noise criteria are written for various purposes. The levels provided by federal agencies, such as HUD and the FAA, are to be used as general planning guidelines, considering cost and feasibility, along with health and welfare. HUD levels also determine if proposed sites are eligible for HUD insurance or financial

TABLE 3.10-4 **LAND USE COMPATIBILITY NOISE EXPOSURE CRITERIA**

Sources	Measure	Residential		Commercial		Industrial		Open Space	
		Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable
Department of Housing and Urban Development (HUD)	DNL	<65	65 - 75	--	--	--	--	--	--
Federal Aviation Administration (FAA)	DNL/CNEL	<65	--	<70	70 - 80	<85	--	<75	--
U.S. Army	DNL/CNEL	<65	65 - 75	<70	70 - 80	<85	--	<75	--
California Planning Guidelines	DNL/CNEL ¹	<60	55 - 70	<70	67.5 - 77.5	<75	70 - 80	<70 - 75	67.5 - 80
California Division of Aeronautics	CNEL ²	<65	65 - 70	--	--	--	--	--	--
City of Mountain View	DNL/CNEL	<55	55 - 65	<60	60 - 70	<65	65 - 75	<55	55 - 65
City of Sunnyvale	DNL/CNEL	<60	60 - 70	<65	65 - 77.5	<70	70 - 80	<70	--
Santa Clara County	DNL	<55	55 - 65	<65	65 - 75	<70	70 - 75	<55	55 - 80

1. Uncorrected CNEL.

2. Annual average.

-- = No criteria for this land use.

Source: NASA Ames Aerodynamics Testing Program Final EIS, 1998.

assistance. The State of California Planning Guidelines were prepared as an information document to provide communities with a means of quantifying noise environments. The California Division of Aeronautics' regulation deals specifically with land use compatibility around airports. The Santa Clara County, Sunnyvale, and Mountain View criteria apply to proposed new construction. The overlap in noise exposure values over several degrees of acceptability show the variation in community acceptability to noise exposure.

a. Federal Noise Criteria

For residential land use, outdoor DNL or CNEL below 65 dB is considered acceptable according to the Department of Housing and Urban Development (HUD) and the Federal Aviation Administration (FAA). According to the FAA, DNL values below 70 dB are normally acceptable for commercial land use. Commercial land use is conditionally acceptable between 70 dB and 80 dB, while industrial land use in areas below DNL values of 85 dB is normally acceptable. Open space use is to occur in areas below 75 dB. HUD does not detail noise criteria for land uses other than residential.

Additionally, the U.S. Army provides guidance on noise and compatible land uses.¹³ Criteria for rating noise will be those from *Guidelines for Considering Noise in Land Use Planning and Control by the Federal Interagency Committee on Urban Noise* (FICUN, 1980).

b. State Noise Criteria

The California State Planning Guidelines (Figure 3.10-1) show DNL or CNEL values below 60 dB to be acceptable for residential land use, and values below 70 dB as acceptable for commercial land use. Industrial land use in areas below DNL values of 75 dB is also acceptable. Open space use is acceptable in areas below 70 dB, depending upon the specific nature of the space; for example, playgrounds are acceptable up to 70 dB and golf courses are acceptable up to 75

¹³ U.S. Army Center for Health Promotion and Preventive Medicine. *Environmental Noise Management, An Orientation Handbook for Army Facilities*. May 2001.

dB. The California Division of Aeronautics considers residential DNL values below 65 dB to be acceptable.

c. Local Noise Criteria

The City of Mountain View has one of the strictest residential noise standards of any municipality in California for residential land use. A DNL below 55 dB is specified for new construction, although many residences throughout the City are already exposed to more severe noise environments. The commercial and industrial land use criteria are 60 dB.

In addition to the noise exposure criteria in the Mountain View Noise Element, a noise ordinance is also referenced in the Noise Element and applied by the City. This specifies a 55 dB maximum noise level from stationary emitters in the City of Mountain View when measured at residential property lines during the daytime, and 50 dB during the nighttime (10:00 p.m. to 7:00 a.m).

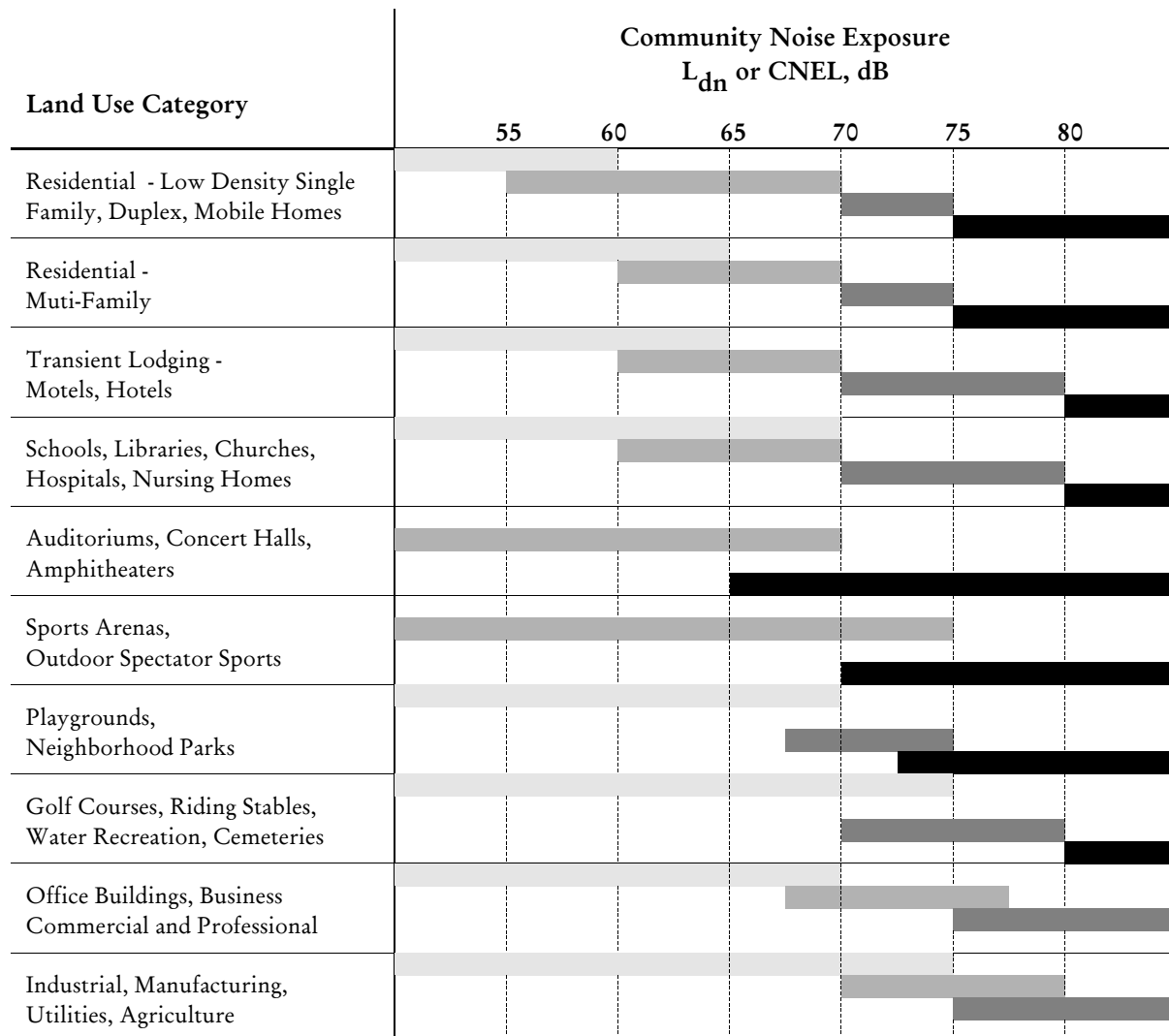
The Sunnyvale criteria follow the State Guidelines rather closely, the only exception being open space use, which is to occur in areas below a DNL of 70 dB. The authors of the Sunnyvale Noise Supplement indicated that DNL should be interpreted as the yearly average throughout their document.

Like Mountain View, Santa Clara County follows the lowest noise acceptability limits found in California for residential land use, at a DNL of 55 dB.

C. Existing Noise Environment

This section describes the existing noise environment at NASA Ames Research Center. Noise exposure contours and levels presented in this section were determined from NASA measurement surveys taken over the past 15 years and noise monitoring conducted for this EIS.

FIGURE 3.10-1 LAND USE COMPATIBILITY FOR COMMUNITY NOISE ENVIRONMENTS



Source: Guidelines for the preparation and content of the Noise Element of the General Plan, State of California Governor's Office of Planning and Research.

INTERPRETATION

Normally Acceptable: Specified land use is satisfactory based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Conditionally Acceptable: New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

Normally Unacceptable: New construction or development should generally be discouraged. If new construction does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Clearly Unacceptable: New construction or development should generally not be undertaken.

Noises generated by NASA Ames and Moffett Field have historically been a source of complaints from surrounding areas. Noise produced by many of the wind tunnels and aircraft operations generate complaints from residents off-site.

Figures showing noise contours described in this section all occur at the end of this section.

1. Wind Tunnels

Among NASA's wind tunnels, the primary noise generators include:

- *40- by 80-Foot Wind Tunnel.* The 40- by 80-Foot Wind Tunnel is a closed circuit wind tunnel. A typical test day can consist of one or two shifts day or night. Each test shift averages approximately four hours, with the wind tunnel running. Current noise exposure levels from this facility are presented in Figure 3.10-2.
- *80- by 120-Foot Wind Tunnel.* The 80- by 120-Foot Wind Tunnel is a non-return wind tunnel that shares the same drive system as the 40- by 80-Foot Wind Tunnel. Because both facilities use the same drive system, only one can be operated at a time. Figure 3.10-3 shows the current noise exposure levels for the 80- by 120-Foot Wind Tunnel.
- *Unitary Plan Wind Tunnels.* The Unitary Plan Wind Tunnel complex consists of three wind tunnels, the 11-foot, the 9- by 7-foot, and the 8- by 7-foot. Only one of these tunnels can be used at a time. At present, only the 11-foot tunnel is regularly used. The 9- by 7-foot Supersonic Wind Tunnel and the 8- by 7-foot Supersonic Wind Tunnel are currently not in operation. Noise levels were measured during operation of the 11-foot Transonic Wind Tunnel in October 2000. Measured noise levels ranged from 80 to 85 dBA along Wagner Lane at distances of 15 to 20 meters (50 to 75 feet) west of the facility. Noise levels along Mark Avenue between Wagner and Boyd Road typically range from 75 to 79 dBA. Noise levels were measured inside the lobby of Building N-234 on Boyd Road directly east of the Wind Tunnel. The measured noise level was 48 dBA and the operating tunnel was barely audible. Noise levels along DeFrance Avenue

were measured at several locations north of the facility and typically ranged from 65 to 70 dBA. Figure 3.10-4 shows the current noise exposure levels for the complex.

- *12-Foot Pressure Wind Tunnel.* The 12-foot Pressure Wind Tunnel also generates noise. Noise levels measured for NASA worker exposure evaluations provide some data for the tunnel. The measured noise levels are 90 dBA at 61 meters (200 feet) from the tunnel at Bushnell Street and 80 to 90 dBA at the cooling towers located north, south, east and west of the facility. Figure 3.10-5 shows the noise exposure contours for the 12-foot Pressure Wind Tunnel.

2. Arc Jets

The arc jets facility is used to perform high temperature materials tests. Noise levels were measured during operation of the arc jets in June 2001. Measured noise levels reached 80 dBA at a distance of 50 meters (146 feet) north of the facility, 78 dBA at a distance of 75 meters (246 feet) to the east of the cooling towers, and 75 dBA along Boyd Road south of the facility. Figure 3.10-6 shows the noise exposure levels for the arc jets facility.

3. Airfield Operations, Traffic, and Other Existing Noise Sources

In addition to the wind tunnels, OARF and arc jets, there are several significant sources at and beyond the NASA Ames Research Center that affect the four planning areas and the surrounding community, most notably airfield operations and traffic noise from local highways.

The NASA Ames Research Center is home to a variety of government aircraft. Noise from Moffett Federal Airfield has been evaluated for the period from 1999 to 2010.¹⁴ Noise exposure contours were determined in terms of the Community Noise Equivalent Level (CNEL). CNEL is considered equivalent

¹⁴ *Assessment of Aircraft Noise Conditions at Moffett Federal Airfield (1999-2010)*, prepared for DMJM by P&D Consultants, Inc., and Michael R. McClintock & Company, August 28, 2000.

to L_{dn} . Figure 3.10-7 shows noise contours from NASA baseline aircraft operations.

Ambient traffic noise measurement were made on Wednesday, September 22, 1999 at four locations within the NASA Ames Research Center. Figure 3.10-8 shows the locations of the noise measurements. Noise levels were measured adjacent to Highway 101 at an exposed location along South Perimeter Road (S1), in a location protected by a sound wall at Westcoat Court (S2), and at a distance from the Highway near Building 547C on Girardi Road (S3) to determine how noise levels decrease over distance. The final measurement was conducted at the intersection of Cody Road and Severns Avenue (S4). The data gathered during these measurement is summarized in Table 3.10-5. The existing DNL noise exposure contours resulting from traffic are shown in Figure 3.10-9.

4. Composite Noise Exposure Contours

Composite noise exposure contours of existing noise conditions at the NASA Ames Research Center are presented in Figure 3.10-10. These contours were developed using the following information:

- Moffett Field airstrip CNEL Noise Exposure, 1999.
- Noise measurement along Highway 101.
- Noise measurement of the Unitary Plan Wind Tunnel.
- NASA Ames Aerodynamic Testing Project EIS.
- Noise measurement of the arc jets.

Thus Figure 3.10-11 represents a composite of noise contours from all of these noise sources.

5. Outdoor Aerodynamic Research Facility

The Outdoor Aerodynamic Research Facility (OARF) is located in the Bay View area. The OARF is used to obtain a wide range of hover and acoustic

TABLE 3.10-5 **AMBIENT TRAFFIC NOISE LEVELS**

Location	L _{eq}	L ₍₁₀₎	L ₍₅₀₎	L ₍₉₀₎	Dominant Noise Source
S1: Recreation Fields south of Dailey Road; microphone 5' above grade	74	76	73	72	Highway 101 Traffic
S2: Westcoat Court; 50' from the property line; microphone 5' above grade	68	69	67	66	Highway 101 Traffic
S3: Building 547C; microphone 5' above grade	56	57	55	54	Highway 101 Traffic
S4: Cody Road at Severns Road; microphone 5' above grade	53	57	50	49	Highway 101 Traffic

Note: Data were gathered during the afternoon of September 22, 1999.

Source: Illingworth & Rodkin.

data on full-scale or small-scale aircraft and other aerospace equipment. High noise-generating projects, such as powered model tests, run an average of two hours per day. Other tests have been administered at the facility for up to seven hours per day.

The experimental physics branch is currently testing hybrid rocket fuel motors at the OARF. Rocket fuel test noise levels were measured by NASA staff in September 2001.¹⁵ The orientation for the rocket test rig and measured noise levels are shown on Figure 3.10-11. The measured noise levels reflect the effects of orienting the facility to mitigate potential noise impacts. The noise levels are generated for very short time intervals, approximately 10 to 20 seconds.

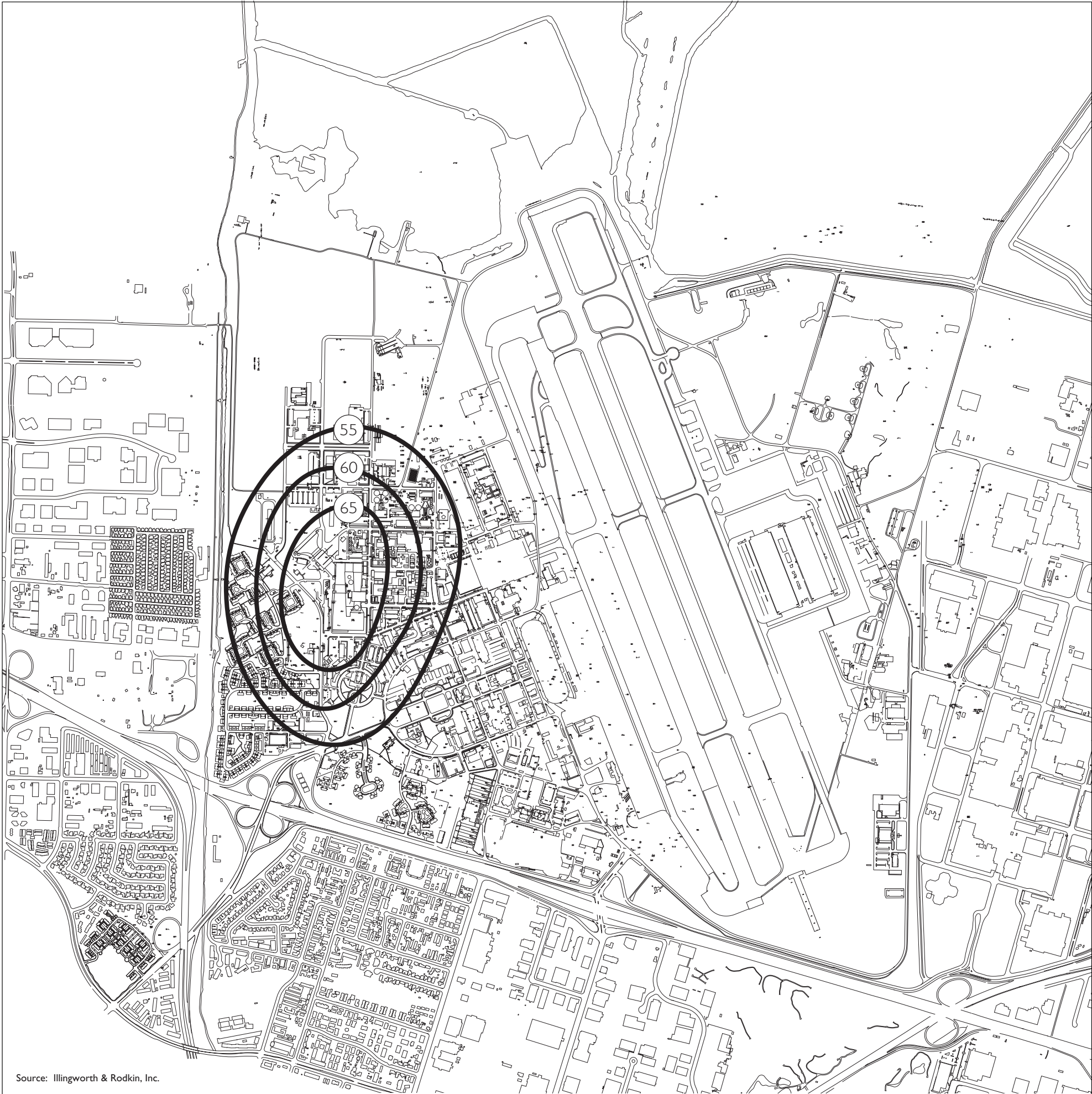
¹⁵ Sound Measurement Results for September 24, 2001 Paraffin Wax Rocket Test Firing, memo from Lynne Kaswani, PAI Corporation to PAI Team.

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FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
AFFECTED ENVIRONMENT: NOISE

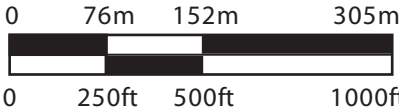
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FIGURE 3.10-2

**EXISTING 40-BY 80-FOOT
WIND TUNNEL OPERATIONS
ANNUAL L_dn NOISE EXPOSURE CONTOURS (dB)**



Source: Illingworth & Rodkin, Inc.



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NASA AMES DEVELOPMENT PLAN FINAL EIS

FIGURE 3.10-3

**EXISTING 80-BY 120-FOOT
WIND TUNNEL OPERATIONS
ANNUAL L_dn NOISE EXPOSURE CONTOURS (dB)**



Source: Illingworth & Rodkin, Inc.

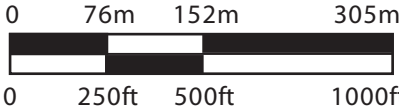


FIGURE 3.10-4

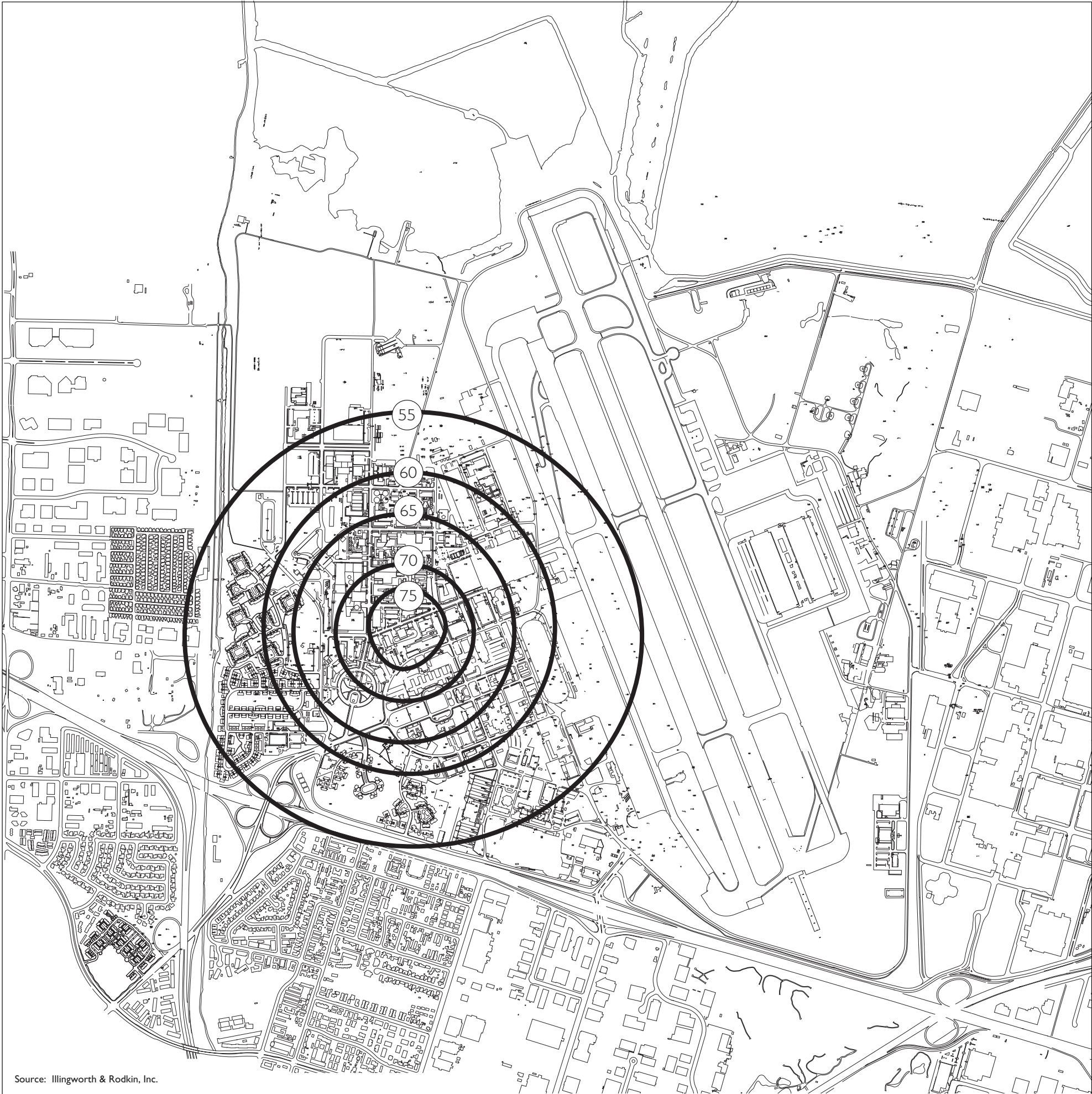
UNITARY PLAN WIND TUNNEL
ANNUAL L_dn NOISE EXPOSURE CONTOURS (dB)



Source: Illingworth & Rodkin, Inc.

FIGURE 3.10-5

12 FOOT PRESSURE WIND TUNNEL
ANNUAL L_{dn} NOISE EXPOSURE CONTOURS (dB)



Source: Illingworth & Rodkin, Inc.

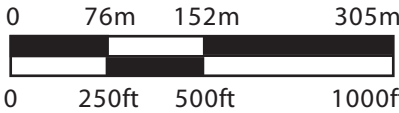


FIGURE 3.10-6

ARC JETS
ANNUAL L_dn NOISE EXPOSURE CONTOURS (dB)



Source: Illingworth & Rodkin, Inc.

FIGURE 3.10-7

**AIRFIELD
CNEL NOISE EXPOSURE (dB)**
(Applicable to both 1999 and 2010)



Source: P&D Consultants, Inc.0

FIGURE 3.10-8

LOCATION OF AMBIENT TRAFFIC NOISE MEASUREMENTS

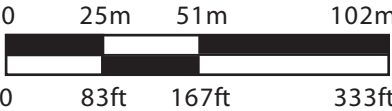
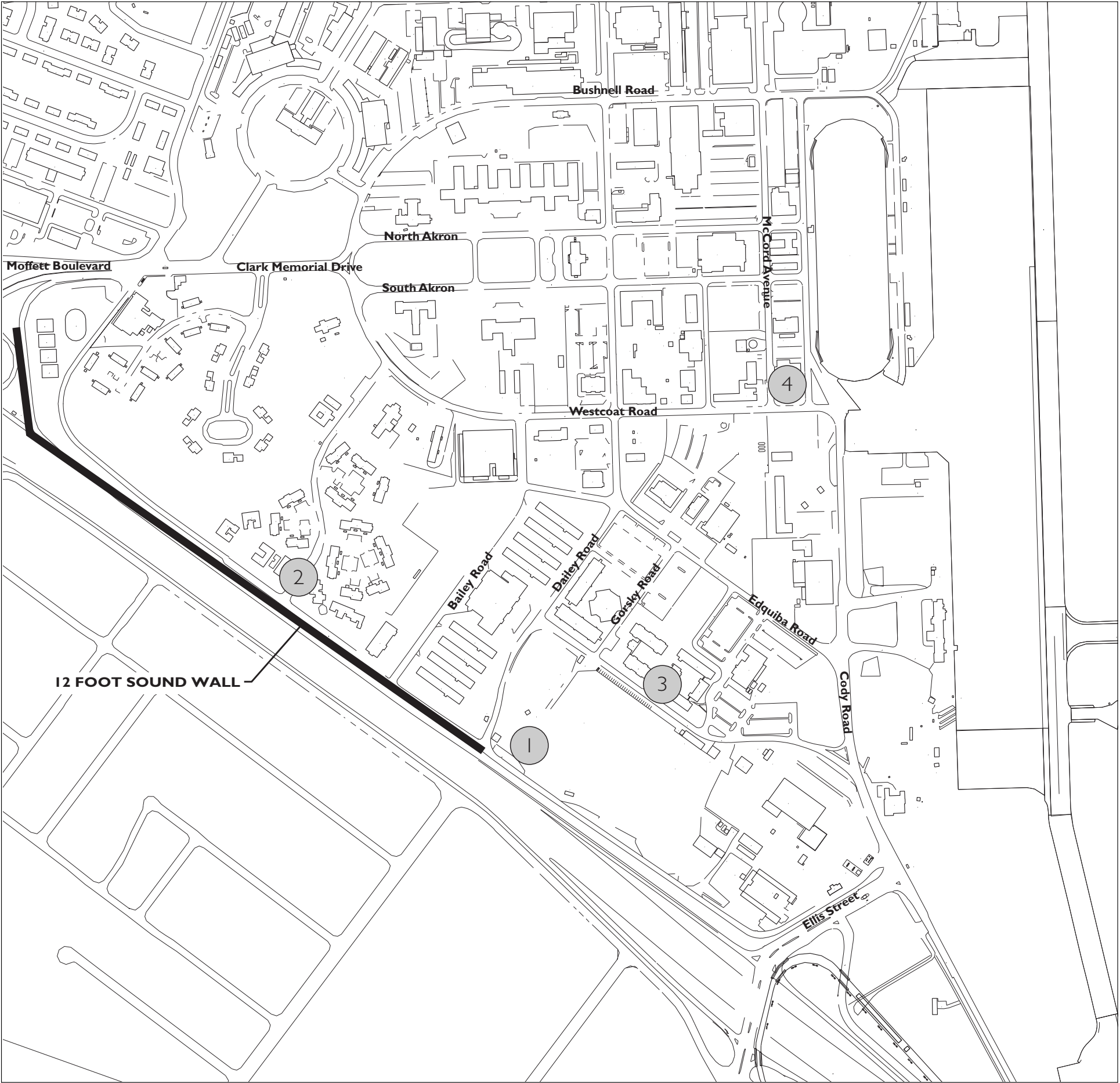


FIGURE 3.10-9

**AMBIENT HIGHWAY 101 TRAFFIC
ANNUAL L_dn NOISE EXPOSURE CONTOURS (dB)**

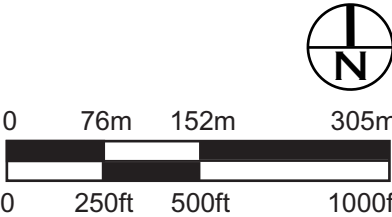


FIGURE 3.10-10

COMPOSITE ANNUAL L_dn NOISE
EXPOSURE CONTOURS (dB)



Source: Illingworth & Rodkin, Inc.





Source: Illingworth & Rodkin, Inc.

FIGURE 3.10-11

HYBRID ROCKET FUEL TEST FACILITY
NOISE LEVELS

Measurement Results		
No.	Location	A-Weighted Sound Level (dBA)
1	OARF Control Room	102
2	Corner of Lindberg Road and Rocket Test Facility Driveway	100
3	North Perimeter Road at DART Facility	62
4	Stevens Creek Trail Gate	73
5	Front of Logistics Supply Facility	76
6	Gate to N254	91

Note: These results are from a specific test September 24, 2001. The duration of this test was approximately 10 seconds. Noise at this facility varies with the type and duration of test.

